KAIBAB NATIONAL FOREST / NORTH KAIBAB RANGER DISTRICT

Burnt Corral Vegetation Management Project

FIRE and FUELS REPORT

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This document serves as an analysis of management alternatives for the Burnt Corral Vegetation Management (BCVM) project area on the North Kaibab Ranger District. The analysis documented here compares the proposed action management alternative against the no action alternative with respect to effects on fire behavior, fuels and smoke.

Introduction

This report serves as an analysis of the possible impacts of the proposed Burnt Corral Vegetation Management project (BCVM) on fire ecology, fire behavior, fuels and smoke. The purpose of this report is to compare the proposed Action Alternative treatment against the No Action Alternative on the landscape and disclose effects of these actions.

The BCVM project is located on the North Kaibab Ranger District, Kaibab National Forest; Coconino County, Arizona. The proposed BCVM project area is approximately, 28,000 acres in size and lies within the southwest portion of the Kaibab Plateau, south-southwest of Lookout Canyon and Forest Service Road (FSR) 22, on the North Kaibab Ranger District (NKRD), of the Kaibab National Forest (KNF). The project lies within Townships 35-37 North, Ranges 1 West -1 East, in Coconino County, Arizona, Gila and Salt River Baseline and Meridian.

The forested areas within the project area are primarily dominated by ponderosa pine, *Pinus ponderosa*, Gambel oak, *Quercus bambelii*, Aspen, *Populus tremuloide,* Pinyon pine*, Pinus edulis,* Utah juniper*, Juniperus osteosperma,* White fir, *Abies concolor*, Douglas fir, *Pseudotsuga menziesii*, Subalpine fir, *Abies lasiocarpa*, and Englemann spruce, *Picea engelmannii*. The project area ranges in elevation from 6,500 to 8,100 feet. These forested areas are intermixed with some small openings and drainages that support a variety of other tree and vegetative species.

The project is within the area prioritized by the Kaibab Forest Health Focus (KFHF), a collaborative, science-based group that has helped guide landscape-level forest restoration efforts across the Kaibab National Forest (KNF). The Burnt Corral Vegetation Management Project is the first in a series of efforts to restore forest health, beneficial fires regimes, and wildlife habitat in the ponderosa pine belt on the west side of the Kaibab Plateau.

The purpose of this project is to achieve desired conditions as defined in the Forest Plan (USDA FS, 2014), consistent with prioritized areas as identified by the Kaibab Forest Health Focus (KFHF; NAU 2009). There is a need to: a) increase diversity in forest stand structure and species composition, b) increase native grasses, forbs, and shrubs within openings throughout the project area, c) maintain existing system of roads and prevent development of new roads, d) reduce the acres of non-native vegetation, and allow for native vegetation succession, e) reduce the potential for uncharacteristically intense (high-severity)wildfires within ecosystems that historically exhibited frequent low intensity (low-severity) fire regimes.

The overall objective of the Burnt Corral vegetation management project, which is consistent with the Forest Service's mission statement, is to improve ecosystem resilience and function at the landscape scale in order to sustain healthy forests and watersheds for future generations.

The major vegetation community types within the project area are at risk from fire. Major vegetation types include: Pinyon-Juniper, Ponderosa Pine, and Mixed Conifer. The fire regime

condition class for these major vegetation community types are moderately altered form historic ranges. Vegetation characteristics like tree density, canopy closure, fuel composition; ladder fuels, and the crown base height of the trees all contribute to the existing condition.

The fire regime condition for these major vegetation types has been moderately altered from their historical fire condition class and now pose a risk to ecosystem health, resiliency to uncharacteristically intense wildfires and drought-related mortality. Possible causes of this departure include (but are not limited to) fire suppression, timber management or lack thereof, livestock grazing, introduction and establishment of exotic plant species, insects and disease.

Fire detection data indicate that during the months of June and July (highest risk for severe fire weather) the Plateau averages 58 fires a year with the majority of those fires being caused by lightening. This would indicate that fire is a prominent disturbance agent and will have influence on this ecosystem in the future. The purpose of this report is to address how management of the area can change the degree of influence a fire disturbance could have on this ecosystem. Potential fire behavior in the area will be central in determining how the ecosystem will respond and recover to wildfire.

Purpose and Need for Action

Purpose 1: Make progress toward desired conditions defined in the Forest Plan (USDA FS, 2014) and consistent with prioritized areas, as identified by the KFHF, with an emphasis on:

a) Improving forest health and vigor, while enhancing habitat conditions to make them more resilient to change in the event of wildfire and other changes in climate or related stressors (i.e., drought, large bark beetle infestations). To achieve this, there is a need to:
   - Return ponderosa pine forest to a fire adapted ecosystem (i.e., high frequency – low intensity surface fires).
   - Manage fire in first entry and follow-up prescribed fire treatments
   - Retain large and old ponderosa pine trees while reducing heavy fuel loads and overly dense stands of smaller trees present in many portions of the project area.
   - Restore forest structure and processes (including natural disturbances such as low-severity fire, watershed function, and nutrient cycling). More specifically this includes:
     - Reducing the risk of uncharacteristic and undesirable wildland fire effects (i.e., either active or passive crown fire), with an emphasis on restoring and maintaining desirable plant community attributes, including fuel levels, fire regimes, and other ecological processes.

b) Restoring the ponderosa pine forest type to increase resilience to disturbance, improve forest health, and improve habitat. To achieve this, there is a need to:
   - Reduce tree density and Stand Density Index (SDI) to the lower range of site occupancy (about 35 – 40% of max SDI in ponderosa pine).

c) Meet KNF LRMP objectives at the mid-scale for desired basal area ranges in the 60 – 80

sq. ft. per acre range with larger trees (i.e. > 18 inches in diameter) contributing the greatest percent of the total basal area, with some areas containing 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g. goshawk post-fledging family areas Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes).

- Mechanically thin up to about 15,000 acres.
- In up to about 5,000 additional acres, perform hand thinning and light mechanical treatment using low-ground pressure equipment for preparation thinning for use and management of prescribed fire and managed wildfire
- Stimulate oak regeneration.
- Stimulate aspen regeneration in the project area especially where it currently exists and at the head of draws, ephemeral streams, and hollows.
- Retain remnant, surviving pine trees in the overlap of the burned area of the 1996 Bridger Knoll fire (about 60,000 acres burned).
- Protect existing ponderosa pine plantations that have been established from the reforestation programs following the Bridger Knoll salvage timber sales.
- Reduce the risk of hazardous, stand-replacing crown fire events in the entire project area, especially portions of the project area that have received no timber treatments nor experienced fire events in the last 25 years.
- Promote uneven-aged forest where lacking, maintain current uneven-aged forest, and create openings in older even-aged stands with patch cuts from one-half to four acres, distributed randomly across the landscape.
- Restore fire-prone stands to more open, historic condition.
- Establish fuel breaks along major forest roads like FSR422, 255, and 425 to provide public safety and protection for firefighters if a high intensity, fast moving crown fire event occurred.
- Create openings (utilizing "Group Selection" cuts), which range in size from ½ acre, up to 4 acres, with a maximum width of 200-feet for any opening 2 acres or greater in size. Openings would be laid out in a random mosaic pattern within treatment units. Selected seed trees would be left in openings greater than 2 acres to maintain and promote desired or healthier genetic traits.

d) Maintain and promote a ponderosa pine/frequent fire forest vegetation community that is a mosaic of forest conditions composed of structural stages ranging from young to old trees.

Proposed Action

The NKRD proposes to mechanically thin up to about 15,070 acres and use wildland fire (including, for this project, both planned (prescribed fire) and unplanned wildfire events) alone or in conjunction with mechanical treatment on up to about 28,060 acres.

Wildland Fire

Treat up to 12,990 acres using wildland fire management. Throughout this document, wildland fire refers to prescribed fire as well as managed wildfire, and includes activities such as preparation thinning (typically achieved through hand thinning and/or the use of mastication

head or similar small, low ground pressure equipment), the construction of control lines, and other treatments associated with appropriate use and management of prescribed fire and managed wildfire.

1. Actions in the Bridger Fire Area (up to about 7,560 acres)
   - Use wildland fire and spot treatments of prescribed fire, as needed, to achieve management objectives
   - Protect existing regenerating trees from fire and mechanical activities as appropriate to meet management objectives
   - Minimize seed-dispersing agents and soil disturbance activities to lessen or avoid the spread of cheatgrass (*Bromus tectorum*).
   - Monitor and implement control measures for invasive species, such as cheatgrass
   - Develop burn plans in consultation with the Arizona Game and Fish Department to ensure wildlife habitat objectives are met.

2. Sensitive Soils and Steep (40% or greater) Slopes (up to about 5,010 acres)
   - Use wildland fire to burn when needed to achieve management objectives
   - Where fuel loading could result in undesirable fire effects, use preparation thinning (either hand thinning or small, low-ground pressure equipment) and piling in preparation for wildland fire
   - Mitigate and avoid negative impacts to sensitive areas by using best management practices and design criteria for soils protection

3. Ponderosa Pine Seed Tree Cuts Approaching Desired Conditions (up to about 420 acres)
   - Use wildland fire to burn when needed to achieve management objectives

Mechanical Thinning and Wildland Fire

Treat up to 15,070 acres using both mechanical thinning and fire.

4. Ponderosa Pine Forest: Northern Goshawk Nest Areas (up to about 2,580 acres). Within areas designated for Northern Goshawk nests or replacement nest areas, about 415 acres are also areas of steep slopes and sensitive soils and would be treated under those guidelines.

   4.1 Mechanical Treatment

   - Where needed to protect and/or enhance nesting habitat, thin from below up to 14”dbh in goshawk nest areas
   - Manage for or retain snags, downed logs, woody debris and old trees, whenever possible

   4.2 Wildland Fire

   - Where possible, use wildland fire in preference to or in coordination with mechanical treatments
   - Wildland fire use may occur pre-or-post mechanical treatment, and multiple fire entries may occur over the project life.

5. Ponderosa Pine Forest: Old Growth Patches (up to about 2,600 acres)

This is a significant portion of the project area that supports relatively dense stands of pre-European settlement trees and retains conditions consistent with pre-European settlement ponderosa pine ecosystems. Some of these areas have been identified as candidate old growth protection sites (henceforth "old growth patches"). However, currently available data are not sufficient for mapping the locations of old growth patches. Access to Forest Service stand data, combined with field validation of both stand data and Northern Arizona University's Landscape Cooperative Initiative (LCI) forest structural models will allow spatially explicit depiction of these patches during NEPA analysis. Preliminary analysis based largely on previous LCI models and guidance provided at the Kanab meeting of the Burnt Corral Stakeholders Group, suggest that a combined area of approximately 2,600 acres would capture most continuous patches of ponderosa pine forest exhibiting old growth conditions. The intent of identifying these old growth patches is to protect areas recognized as current and future reservoirs of old growth forest composition, structure and function. These areas will be managed in conjunction with design features for retaining old and large trees, generally (see below), to ensure the adequate representation of the composition, structure and function of old growth stands, including their living and non-living components, into the future.

5.1 Mechanical Treatment

- Conduct limited mechanical treatments that thin post settlement trees less than 16 inch dbh as necessary to reduce ladder fuels
- Retain structural diversity
- Retain old growth components including large snags, downed logs, coarse woody debris, and large and old trees

5.2 Wildland Fire

- Use wildland fire in coordination with mechanical treatments
- Wildland fire use may occur pre- or post-mechanical treatment, and multiple fire entries may occur over the project life

6. Ponderosa Pine Forest: Remaining Area (Up to about 9,530 acres)

For the remaining acres of ponderosa pine, including Northern Goshawk PFAs (about 9,320 acres), the following actions are proposed:

6.1 Mechanical Treatment

- Use group selection cuts varying in shape to create opening that are an irregular and heterogeneous forest mosaic, characterized by treatments from ¼ to 4 acres in size, with a maximum width of 200 feet. The intent of these selection cuts is to manage for current and future uneven-aged conditions while reducing fuel loads and fuel continuity, without creating an homogeneous stand structure or a regular or repetitive "cookie cutter" structure of alternating dense stands and openings.
- Strategically place treatments and vary the sizes of thinned areas on the landscape, taking advantage of topography and roads, particularly East-West roads, to achieve fire management objectives
- Generally, treat more intensively on south-facing slopes and areas upwind of NOGO nest

areas, old growth patches, and other areas of denser trees of particular value or vulnerability to fire
- Generally forego mechanical treatment in areas where fire models predict passive surface fire
- Develop and/or maintain structural diversity, including some areas with interlocking crowns and wildlife hiding cover at the stand level
- Develop and/or maintain at least 3 age classes in roughly even proportions across any 100-1,000 acre subunit

6.2 Wildland Fire
- When possible, use wildland fire in coordination with mechanical treatments
- Wildland fire use may occur pre- or post-mechanical treatment, and multiple fire entries may occur over the project life

7. Mexican Spotted Owl Habitat (Up to 358 acres)

Three hundred and fifty eight acres of the project is designated as Mexican spotted owl Recovery Habitat and will be managed consistent with the Mexican Spotted Owl Recovery Plan (2012). About one hundred eighty acres of Recovery Habitat overlap with steep slopes and sensitive soils. Any guidelines developed for steep slopes and sensitive soils will be used as operational guidance and will conform to the Recovery Plan. All treatments will move the habitat towards Nesting/Roosting Habitat desired conditions within the Recovery Plan (Table C.3, pg. 278).

7.1 Mechanical Treatment
- Thin from below up to 12" DBH, in some cases thinning may only occur up to 9" DBH to meet desired conditions.
- Multiple mechanical entries may be required during the life of the project to meet desired conditions.
- Retain Mexican spotted owl key habitat elements required by the Recovery Plan. These elements include hardwoods, large snags (>18" DBH), large downed logs (>18" DBH at any point), and large trees (>18" DBH).
- Maintain the Primary Constituent Elements (PCEs) of Mexican spotted owl Critical Habitat. Areas outside of Recovery Habitat (i.e. Ponderosa pine) will be treated to protect the habitat from uncharacteristic high intensity wildlife and other natural disturbances.

7.2 Wildland Fire
- Wildland fire will be implemented as appropriate to retain the key elements mentioned above in 7.1 as well Critical Habitat PCEs.
- Prescribed fire may occur pre- or post-mechanical treatment. Multiple fire entries may occur over the life of the project within Recovery Habitat to meet desired conditions.

The project is proposed in response to the goals and objectives of the National Fire Plan (USDA FS 2000) and the Kaibab National Forest Land Management Plan (Forest Plan, February 2014). There is an apparent need for change to reduce the risk of uncharacteristic fires and restore the

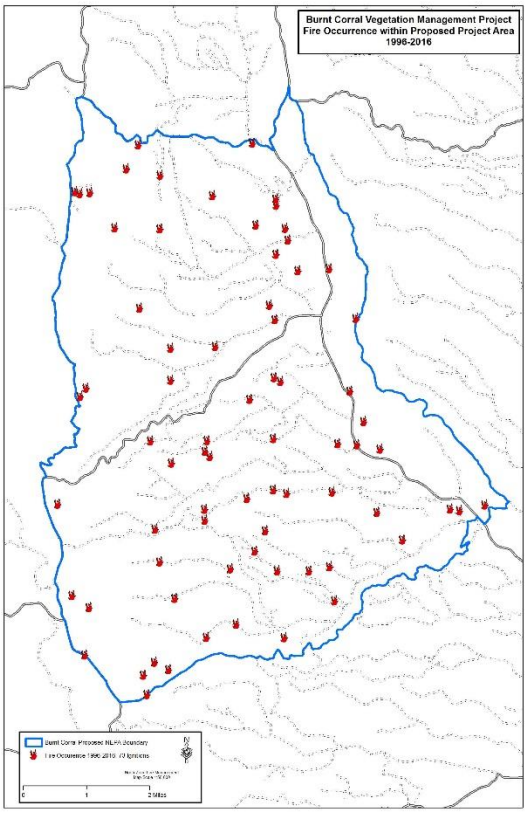
structure, species composition, and function of forested ecosystems. Thus, there is a need to:

- Reduce forest fuel loads and tree densities within the proposed project area.
- Reduce ladder fuels and increase tree crown base heights
- Create openings in the forest canopy that helps drop fire to the surface, and
- Reduce fuel loadings and reduce understory tree densities adjacent to major road systems within the proposed project area to improve firefighter safety and help insure public safety in the event of a wildland fire.

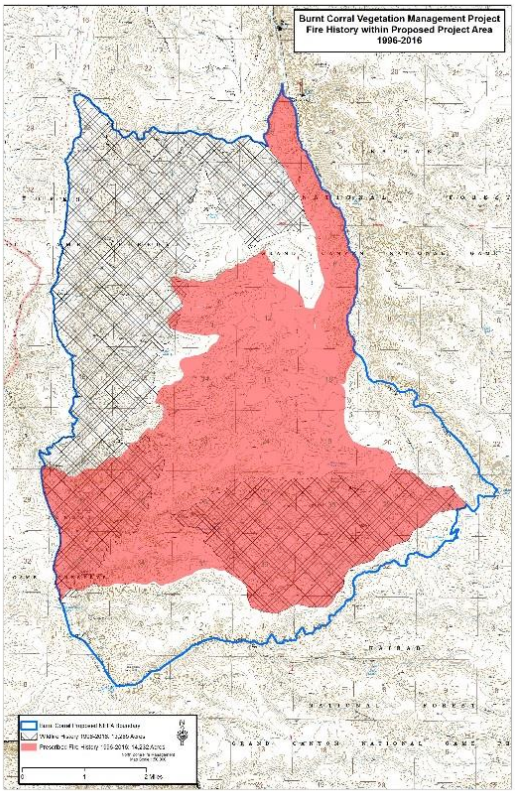
Overall Existing and Desired Conditions:

Forests of central and northern Arizona have experienced major changes in ecological structure, composition and process because of relatively recent human activities such as cattle grazing, fire suppression, timber production and general human habitation in and near these forests (Covington and Moore 1994, Swetnam et al. 1999). One of the most apparent and critical changes in these forests is vulnerability of these ecosystems to uncharacteristic high severity fire. Such fires not only pose safety risks and valuable losses to human interests, but they also can drastically change and damage ecological integrity of that system. Current structure and composition of the forested areas within the project area increases the likelihood of the area experiencing stand replacing crown fire. A crown fire would alter ecosystem function, destroy much of the existing wildlife habitat, create sediment problems to the watershed and decrease the desirability of the area from a recreation and visual quality standpoint, and pose a risk to life, property and public safety including the safety of fire suppression crews.

The Kaibab Plateau has experienced many fires over the past several decades including several that burned with high severity and caused significant change and damage to the Plateau ecosystem. For example, the Warm Fire (just south of and adjacent to the Jacob Lake) was started by lightening on June 8, 2006. The fire met the criteria for a management objective focused on resource benefit, and was consistent with the Kaibab National Forest Plan (Forest Plan, April 1998- as amended), Kaibab Fire Management Plan (January 2011), and the Federal Wildland Fire Management Policy (January 2001- updated February 2009). The Warm Fire was managed under a resource benefit objective for approximately 2.5 weeks, during which time, approximately 19,000 acres were treated and beneficial fire effects were obtained. However, on June 25, winds pushed the fire south, outside of the Maximum Manageable Area (MMA). Approximately 39,000 acres burned between June 25 and July 4 while the fire was managed under a wildfire suppression strategy, much of which burned at high intensity and resulted in severe fire effects and caused significant change and damage to the Plateau ecosystem. Based on the accumulation of forest fuels, tight canopy spacing, abundant ladder fuels and low canopy base heights (CBH); it is expected that many of the areas within the BCVM project area could burn with similar high severity if no management occurs.



Map1: Fire Occurrence



Map 2: Fire History by Type

Between 1996-2016, seventy three wildfire ignitions have occurred within the BCVM project area (Map 1).

The proposed project area has experienced multiple fire disturbances between 1996-2016. In the last twenty years the project area has had approximately 13,285 acres burn during unplanned wildfire events and approximately 14,232 acres burn during planned prescribed fire events (Map 2).

Fire behavior is the manner in which a fire reacts to available fuels, weather, and topography. A change in any of these components results in a change in fire behavior (DeBano et al 1998). Fire behavior is complex, with many contributing factors in the categories of topography (slope, aspect, elevation), weather (climate, air temperature, wind, relative humidity, atmospheric stability) and fuels (size, type, moisture content, total loading, arrangement) (Agee 1993). These three components comprise the fire environment, surrounding conditions, influences, and modifying forces determine fire behavior (NWCG 2004). Topography and weather at a given location cannot be controlled by management, therefore, fuel, comprised of live and dead vegetative material, is the only controllable factor. Weather conditions such as drought, high temperature, low humidity, and high wind play a major role in the spread of wildfires and are influenced by topography and location of mountains as well as global influences such as La Niña and El Niño. Weather conditions are a major factor in the initiation and spread of all wildfires, but Omi and Martinson (2002), and Strom and Fulé (2007) found that stands with prior fuel treatments experienced lower wildfire severity than untreated stands burning under

the same weather and topographic conditions. Fuel management modifies fire behavior, ameliorates fire effects, and reduces fire suppression costs and danger (DeBano et al 1998). Manipulating fuels reduces fire intensity and severity, allowing firefighters and land managers more control of wildland fires (Pollet and Omi 2002). Fuel management can include reducing the loading of available fuels, lowering fuel flammability, or isolating and breaking up large continuous bodies of fuels (DeBano et al 1998). The existing and foreseeable arrangement and management of fuel in the project area is therefore very important when addressing the risk of wildfire in the area.

During the Fall of 2016, the Kaibab National Forest requested assistance from Grand Canyon National Park (GCNP) to install 50 pre-treatment Rapid Assessment Protocol (RAP) monitoring plots (Burnt Corral Vegetation Management Project Rapid Assessment Protocol Plot Monitoring Report 2016) within the Burnt Corral project area. The main objectives of the monitoring plots were to quantify the pre-treatment fuel loading and existing timber stand conditions. Overall plot data form the RAP plots is listed below:

Surface Fuel Loading

Total pre-treatment fuel loading in the Burnt Corral project averaged 26.4 tons/acre with individual plot values ranging from 7 to 79 tons/acre (Table 1). Small woody fuel (1-, 10-, and 100-hr TLFM) averaged 1.8 tons/acre and coarse woody fuel (1000-hr TLFM) averaged 4.3 tons/acre. Together, litter and duff fuel loading averaged 20.2 tons/acre. Litter and duff depth were each 1 inch on average. Duff contributes the most to total fuel loading in the plots (Table 1).

Table 1. Mean (± 80% Confidence Interval), minimum, and maximum pre-treatment dead surface fuel loading in the Burnt Corral monitoring plots (n = 50). TLFM = time lag fuel moisture

Dead Surface Fuel Category	Mean ± 80% CI	Min - Max
Total Loading (tons/acre)	26.4 ± 3.0	7.0 – 79.2
1-, 10-, & 100-hr TLFM (tons/acre)	1.8 ± 0.3	0 – 5.4
1-hr TLFM (tons/acre)	0.1 ± 0.02	0 – 0.6
10-hr TLFM (tons/acre)	0.8 ± 0.1	0 – 2.9
100-hr TLFM (tons/acre)	1.0 ± 0.2	0 – 4.2
1000-hr TLFM (tons/acre)	4.3 ± 1.8	0 – 56.0
Sound 1000-hr TLFM (tons/acre)	1.1 ± 0.5	0 – 13.5
Rotten 1000-hr TLFM (tons/acre)	3.3 ± 1.4	0 – 42.5
Litter & Duff (tons/acre)	20.2 ± 2.1	5.3 – 59.2
Litter (tons/acre)	2.8 ± 0.2	1.2 – 5.7
Duff (tons/acre)	17.4 ± 2.0	2.7 – 56.1
Litter & Duff Depth (inches)	2.0 ± 0.2	0.8 – 4.4
Litter Depth (inches)	1.0 ± 0.07	0.4 – 2.0
Duff Depth (inches)	1.0 ± 0.1	0.2 – 3.3

Tree Measurements

Pre-treatment large (>16" DBH) living tree density was 38 trees/acre and basal area was 114 sq. ft./acre, on average (Table 2). Ponderosa pine (*Pinus ponderosa*) trees made up the overwhelming majority of the living large tree density (average of 99%) and basal area (average of 100%). The only other large tree species present was Gambel oak (*Quercus gambelii*)

accounting for an average of less than 1% of density and basal area. Large snags were observed in only 6 plots with 1 or 2 snags per plot.

On average, intermediate (6 – 16" DBH) living tree density was 59 trees/acre and basal area was 34 sq. ft./acre prior to treatment (Table 2). Ponderosa pine and Gambel oak were again the dominant species in the intermediate size class. Ponderosa pine averaged 85% and Gambel oak averaged 9% of the intermediate living tree density and basal area. Douglas-fir (*Pseudotsuga menziesii*) and quaking aspen (*Populus tremuloides*) were the next most common species in the intermediate class with each averaging 2% to 4% of the living tree density and basal area. Intermediate-sized snags were largely oak and ponderosa pine, which made up an average of 33% and 28%, respectively, of the snag density. Intermediate-sized snag density of white fir (*Abies concolor*), Utah juniper (*Juniperus osteosperma)*, and aspen averaged 11-17% of the total.

Density of living sapling (1 – 6" DBH) trees before treatment averaged 194 trees/acre (Table 2). Dead sapling trees were not sampled. The majority of trees in the sapling size class were ponderosa pine (54% on average), Gambel oak (27% on average), or aspen (15% on average). Douglas-fir, white fir, and pinyon pine (*Pinus edulis)* each accounted for less than 3% of the sapling density.

Living seedling (<1" DBH) tree density averaged 1227 trees/acre before treatment (Table 2). Dead seedling trees were not sampled. Most of the seedling trees were Gambel oak (37% on average), ponderosa pine (20% on average), or aspen (20% on average). White fir, Douglas-fir, and juniper seedlings were only seen on 4 plots.

Across all plots, the average height of living large trees within monitoring plots was 63 feet and the average height of dead large trees was 58 feet (Table 2). Intermediate living trees averaged 42 feet tall and dead trees averaged 26 feet tall within monitoring plots. Average crown base height for large trees was 29 feet and was 16 feet for intermediate trees (Table 2).

Table 2. Mean (± 80% Confidence Interval), minimum and maximum pre-treatment tree density, basal area, height and crown base height in the Burnt Corral monitoring plots (n = 50). DBH = diameter at breast height, NR = not recorded, NA = not applicable

	Living Trees		Snags	
Variable / Size Category	Mean ± 80% CI	Min – Max	Mean ± 80% CI	Min – Max
Density (trees/acre):				
Seedling tress (<1" DBH)	1227 ± 389	0 – 9434	NR	NR
Sapling tress (1-6" DBH)	194 ± 44	0 – 1121	NR	NR
Intermediate-sized trees (6-16" DBH)	59 ± 9	0 – 202	3.2 ± 1.4	0 – 27
Large-sized trees (>16" DBH)	38 ± 5	0 – 108	2.2 ± 1.2	0 – 27
Basal area (sq. ft./acre):				
Intermediate-sized trees (6-16" DBH)	34 ± 6	0 – 114	1.4 ± 0.7	0 – 19
Large-sized trees (>16" DBH)	114 ± 15	0 – 331	5.2 ± 2.9	0 – 75
Average tree height (feet)[1]:				
Seedling tress (<1"DBH)[2]	3.6 ± 0.3	2 – 8	NR	NR
Sapling tress (1-6" DBH)[2]	18.0 ± 1.0	8 – 27	NR	NR

Intermediate-sized trees (6-16" DBH)	42.2 ± 4.3	3 – 88	26.4 ± 7.7	1 – 47
Large-sized trees (>16" DBH)	63.1 ± 7.4	2 – 122	58.5 ± 10.0	36 – 85
Average crown base height (feet)[1]:				
Intermediate-sized trees (6-16" DBH)	16.0 ± 1.9	5 – 41	NA	NA
Large-sized trees (>16" DBH)	29.4 ± 2.6	5 – 62	NA	NA

[1]height values were calculated as the average height of trees within a particular size class in the plot. Mean height is the mean of average plot height for only those plots with trees present in a particular size class.
[2]height values for seedling and sapling trees were recorded by 1 meter height classes. The shortest height class recorded was 0 – 0.6 meter.

Understory Cover

Herbaceous (grass and forb) cover averaged 30% and shrub cover averaged 18% across all plots. A total of 10 non-native species were encountered during the pre-treatment monitoring (Table 3). 23 of the 50 plots (46%) had non-native species observed within the sampling area, and the maximum number of non-native species observed in any single plot was 5. On average, across all plots, non-native species cover was just under 4%.

Table 3. Non-native species present in Burnt Corral monitoring plots (n = 50). # Obs. is the number of plots with recorded observations of the species.

Scientific Name	Common Name	# Obs.
Bromus inermis	smooth brome	14
Bromus tectorum	common cheatgrass	5
Conyza canadensis	Canadian horseweed	1
Chenopodium sp.	Non-native species of goosefoot	1
Phleum pratense	timothy	3
Tragopogon dubius	yellow salsify	3
Verbascum thapsus	common mullein	10
unknown grass	non-native	3
unknown forb	non-native	2
unknown Asteraceae	non-native	1

Two factors that contribute to stand replacing crown fire are surface and canopy fuel distribution. Both fuel components provide ecological benefits when found in natural amounts and configurations but can also cause harm to an ecosystem when outside of that natural range. It is therefore important to maintain these fuels while also not allowing them to become overly abundant. Based on the findings from the RAP report, surface fuel loadings are above the desired conditions of 5 to 30 tons per acre. Surface fuel loadings are not evenly distributed across the project area and in some places canopy fuels are overly abundant and continuous.

Surface fuels play an important role within an ecosystem. Litter and duff layers help protect soil from erosion and provide nutrients to the soil. However, layers of duff and litter that are too thick, suffocate soil and burn with high intensities, which create longer flame lengths and residence time (amount of time fire is present in one spot). This causes higher severity or damage to existing vegetation. Coarse woody debris, logs larger than 3" in diameter, also have an important ecological role in soil erosion mitigation and for wildlife habitat, but can contribute to more severe fire behavior when in excess. Coarse woody debris have little influence on rates of spread of fire but burn with higher intensity and with longer duration that could result in greater damage to soil and surrounding vegetation (Brown et al. 2003, DeBano et al. 1998, Harmon et al. 1986). The existing surface fuel loading is measured to be approximately 7 to 79 tons per acre in the BCVM project area. Past timber sale cutting units are generally in the 5 to 10 tons per acre range, plantations and the heavier-cut shelter wood

and seed tree treatments are in range of 3 to 7 tons per acre, old thinning units which slash was lopped and scattered are about 10 to 15 tons per acre, and untreated areas range from about 10 to 66 tons per acre. Areas that have been prescribed burned in the recent past (1990's) are generally about 5 to 10 tons per acre. Desired conditions for surface fuels are to have between 5 to 30 tons per acre. This would indicate that a reduction in surface fuel loadings is needed in most of the project area. The area also has little opportunity for sunlight penetration to the forest floor which has reduced the herbaceous cover under the canopy of trees. Desired conditions would increase cover, diversity and production of herbaceous species in the understory. These herbaceous plants are important to soil productivity, wildlife and the maintenance of fire as an important and natural ecosystem disturbance.

Canopy fuel distribution and the risk of stand replacing crown fire can be measured by looking at the average Crown base height (CBH), Torching Index (TI), and Flame Length (FL) across a stand. Crown base height (CBH) is the lowest height above the ground at which there sufficient amount of canopy fuel to propagate fire vertically into the canopy (Scott and Reinhardt 2001). The lower the crown base height the easier it is for a given surface fire to initiate a crown fire (Van Wagner 1977). Torching Index (TI) is the 20-foot wind speed (in miles per hour) at which a surface fire is expected to ignite the crown layer. Torching index depends on surface fuels, surface fuel moisture, canopy base height, slope steepness, and wind reduction by the canopy. As surface fire intensity increases (with increasing fuel loads, drier fuels, or steeper slopes) or canopy base height decreases, it takes less wind to cause a surface fire to become a crown fire (Scott and Reinhardt 2001). Crown base height coupled with torching index allows managers to understand how likely a crown fire is to initiate and sustain itself across a stand. Existing conditions in the project area demonstrate crown base heights between 5 to 62 feet coupled with torching indices ranging from 4 mph to 19 mph. Desired conditions for the project area would be to have average canopy base heights above 12 feet in the Pinyon-Juniper, above 6 feet in the mixed conifer, and above 35 feet in the ponderosa pine. The desired condition for torching indices (TI) would be to have an average TI in the Pinyon- Juniper above 25 mph, above 25 mph in the ponderosa pine, and above 25 mph in the mixed conifer. The overall desired condition for flame length in all three vegetation types would be flame length less than 4 feet. These increases in CBH and TI would reduce the percent of the landscape with potential to burn as passive and active crown fire. Passive crown fire refers to fire that does not carry continuously through the crown fuels, but burns crowns intermittently, such as when individual trees or groups of trees torch. Active crown fire carries continuously through the canopy of trees. A flame length of 4 feet or less is desired, because flame lengths greater than 4 feet are typically greater than what initial attack firefighters can safely suppress without the use of mechanized equipment or air support.

These desired conditions for surface and canopy fuels would allow fire to function as a natural disturbance within the ecosystem without causing loss to ecosystem function or to human safety, lives and values. The desired forest conditions would provide for diversity within stands without sustaining crown fire. These conditions would allow managers to use wildfire and prescribed fire to maintain the area as a functioning ecosystem.

Alternatives Being Analyzed:

Two alternatives are being analyzed to determine how well each would meet the purpose and need for the BCVM project, for detailed descriptions of these alternatives see the Silviculture report (Domis 2015) prepared for the BCVM project area:

Alternative 1- No Action:
Current and existing management plans would continue to guide the project area. No mechanical treatment or prescribed burning is being proposed under this alternative. Wildfire would continue to be managed with protection and/or resource benefit objectives as appropriate.

Alternative 2- Proposed Action:
The proposed action would include the use of mechanical treatments and prescribed burning to reduce the potential for uncharacteristic high intensity wildfire events in order to protect and maintaining key ecosystem components. The priority would be a reduction in vegetation density to provide for firefighter and public safety, promote forest health, and reduce the potential effects for climate change in the event of a high intensity wildfire. The entire project area may receive prescribed fire treatments (Approximately 28,000 acres). Prescribed fire treatments could involve: broadcast burning, jack pot burning, and pile burning. Both mechanical and prescribed fire treatments would follow both the northern goshawk and visual quality guidelines, and reduce stand density to restore forest health, resilience, and resistance to destructive crown fire**.** For this project and entry, the NKRD has proposed implementation of the Kaibab Forest Plan.

In most areas the mechanical treatments would be followed with prescribed fire or be treated with a standalone prescribed fire treatment. Broadcast burns would aim to reduce surface fuel loads to the desired tons per acre. Mechanical and prescribed fire treatments would focus on creating surface fuel loads and tree canopies that are more prone to surface fire and are more resistant to passive and active crown fires.

Methodologies for Analyses:

In order to understand how each alternative will affect the project area based on existing conditions, desired conditions and the purpose and need of this project; the following criteria were examined. Average crown base height, crowning index, and flame length were determined using the Fire and Fuels Extension, FFE (Reinhardt and Crookston 2003) to the Forest Vegetation Simulator, FVS (Dixon 2002). The Fire and Fuels Extension (FFE) to the Forest Vegetation Simulator (FVS) links models of fire behavior, fire effects, fuels loading and snag dynamics to tree growth metrics (Reinhardt and Crookston 2003). In this analysis basic outputs for Crown Base Height, Crowning Index, and Flame Length were recorded using parameters from the Central Rockies Southwestern ponderosa pine variant to FVS. Data used in FVS and FFE were from field sampled stand exams and the RAP plot monitoring conducted in the project area.

It is important to note that a simulated "cool-end" prescribed fire was simulated in 2020, post mechanical treatments in the ponderosa pine and mixed conifer vegetation types within the Plateau Facilities Fire Protection Project (PFFPP) project area to reflect the associated prescribed fire treatments post mechanical thinning operations. This simulated "cool-end" prescribed fire was applied to the action alternative; therefore it is important to look at the post treatment outputs (mechanical and prescribed) for the action alternative. The FVS model used to simulate treatment in this analysis utilized 2 year time frame increments post completion of the mechanical treatments in year 2018 for modeling purposes. This is an artifact of the modeling process; it is important to look at the effects on fuels and fire behavior over longer periods of time when compared to the effects of mechanical treatments. The "cool-end" prescribed fire was simulated to reflect that 70% of the stand burned under this treatment. High fuel moistures were utilized because FFE overestimates fire effects. The prescribed fire parameters for the simulated prescribed fire treatment in 2020 were as follows: 20' Foot Wind Speed: 10 mph, Wind Direction: 60 degrees, 1-hour fuel moisture: 6%, 10 hour fuel moisture: 8%, 100 hour fuel moisture: 10%, 1,000 hour fuel moisture: 12%, duff moisture: 125%, and live fuel moisture: 120%. It is also important to note that no further treatments occur post 2020, that timeline was compared to reflect how well the action alternative is maintaining resiliency against the potential for passive and active crown fires. Alternative 1 or the No Action alternative would also represent current conditions for this landscape moving forward through time with no mechanical or prescribed fire treatments. The FFE outputs for canopy base height, torching index, and flame length prior to mechanical or prescribed fire treatment serve as the baseline for the existing conditions and were utilized in comparing the no action alternative against the action alternative.

Additional fire behavior modelling utilizing Behave Plus was performed utilizing historical weather and fuel moisture values at both the 75th and 97th percentile weather conditions. A pre-treatment fuel model of TL8 was utilized for pre-treatment conditions and a fuel model TL3 was utilized to reflect post treatment conditions. Basic fire behavior outputs: Rate of Spread and Flame Length were analyzed to determine post treatment effectiveness when comparing the no action vs. the action alternative.

Alternative Analysis Results:

The following section describes the results of each analysis by alternative with supporting discussion of how results were obtained.

FVS/FFE Results:

All results from FFE are stand averages and therefore can give a general idea of what stand conditions look like but cannot address the spatial distribution of specific metrics. The desired conditions are for stand averages and therefore allow for some areas within a stand to be outside of the desired condition range but be surrounded with conditions closer to the overall desired conditions. For example Crown Base Height is desirable to be above 35 feet as an average over a ponderosa pine stand. This could mean that many patches within the stand may have a higher CBH or a lower CBH but the overall average for CBH for the stand is within acceptable limits. As seen in the table below, the Proposed Action Alternative improves Crown

Base Height (CBH), Torching Index (TI), and Flame Length (FL) when compared to the No Action Alternative. The Proposed Action Alternative does not fully meet desired the conditions for each vegetation type, however the proposed action does improve conditions when compared against the No Action Alternative and moves the overall conditions towards the desired condition. The No Action Alternative continues to move the existing conditions forward though time with no management action, therefore a continued risk for high intensity wildfire within the project area would continue to be present.

Table 4: Fire and Fuels Extension to the Forest Vegetation Simulator results: No Action Alternative vs. Proposed Action post treatment (mechanical and prescribed fire, or mechanical only in the Pinyon-Juniper).

		No Action Existing Conditions	Proposed Action	Desired Condition
Pinyon Juniper	**CBH (feet)**	**6.81**	**11.50**	**12**
	TI (mph)	**11.72**	**23.45**	**25**
	FL (feet)	**9.14**	**6.74**	**4**
Ponderosoa Pine	**CBH (feet)**	**10.97**	**45.22**	**35**
	TI (mph)	**18.76**	**138.79**	**25**
	FL (feet)	**11.33**	**3.75**	**4**
Mixed Conifer	**CBH (feet)**	**2.43**	**4.61**	**6**
	TI (mph)	**4.62**	**12.68**	**25**
	FL (feet)	**27.46**	**9.93**	**4**

CBH= Canopy Base Height, TI= Torching Index, FL= Flame Length

Direct/Indirect Effects- No Action Alternative (Alternative 1)

Current and existing management plans would continue to guide the project area. No mechanical treatment or prescribed burning is being proposed under this alternative. Wildfire would continue to be managed with protection and/or resource benefit objectives as appropriate.

Effects of the No Action Alternative will allow the ecosystem to move toward more and more unsustainable characteristics. Canopies will continue to close and provide more and more continuous fuel across the landscape. This can be concluded from comparing the existing conditions for Crown Base Height (CBH), Torching Index (TI), and Flame Length (FL) outputs in the FFE models for the project area for each vegetation type. The No Action Alternative would continue the potential for high severity fire effects (passive and active crown fire potential). This canopy fuel accumulation has negative effects on understory vegetation and will continue to suppress the production of forbs, grasses, and shrubs. Over time it can be expected that most of the forest will have little to no understory due to sunlight not penetrating the canopy. The combination of abundant and continuous canopy fuels, the lack of understory vegetation and high fire severity fire potential remains in the project area for the foreseeable future. For example, high intensity fire behavior associated with passive or active crown fires can lead to large stand replacement fire events that are not typically associated with the historical fire

regime of Southwestern Pinyon-Juniper, ponderosa pine or mixed conifer forests. These high intensity fire behavior patterns can cause long range spotting and compromise firefighter and public safety, reduce soil productivity and remove valuable nutrients in the soil that promote stand regeneration post a wildfire event. The No Action Alternative shows a continued potential for passive and active crown fire potential, which would indicate more resistance to control and spotting potential.

Basic fire behavior outputs for a Fuel Model TL8 would remain unchanged; Rates of Spread could be expected to range between 1-15 chains/hour (66-990 feet/hour) with a 20-foot windspeed between 0-40 miles per hour. Flame lengths would range between 1-7 feet and demonstrate resistance to control and require mechanized equipment for suppression operations on flame lengths at 4 feet or greater.

Direct/Indirect Effects- Proposed Action (Alternative 2)

Pinyon-Juniper Vegetation Type

The Proposed Action in the Pinyon-Juniper stands improves Canopy Base Height to 11.5 feet, increases the Torching Index to 23.45 mph and lowers Flame Length to 6.74 feet. This type of expected fire behavior is likely to exhibit torching (passive crown fire) and less likely to produce lofted embers that start more fires, and these fires generally burn cooler and slower and typically burn in the surface fuels. Fire behavior conditions that would occur under these conditions would range from creeping surface fires with flame lengths less than one foot burning in conifer litter and duff; to active surface fire burning freely in all surface fuels, and actively torching groups of seedling and sapling sized (1-6 inch DBH) trees. The more active fires may also occasionally torch out individual overstory trees of various sizes as well as small groups of overstory trees with continuous ladder fuels beneath them. These desired forest conditions would provide for diversity within stands without sustaining crown fire. These types of fire are less likely to cause high fire severity effects, less ecosystem damage, and move the forest towards desired conditions. By moving towards these desired conditions for surface and canopy fuels; fire would be allowed to function as a natural disturbance within the Pinyon-Juniper ecosystem without causing loss to ecosystem function or to human safety, lives and values. The desired forest conditions would provide for diversity within stands without sustaining crown fire. These conditions would allow managers to use wildfire and prescribed fire to maintain fuel accumulations within the desirable range, assist in maintaining desirable stand structure, and otherwise let fire perform its role as a natural disturbance factor within the ecosystem. Both broadcast and pile burning treatments could occur in this vegetation type.

Ponderosa pine Vegetation Type

The Proposed Action in the ponderosa pine stands improves Canopy Base Height to 45.22 feet, increases the Torching Index to 138.79 mph and lowers Flame Length to 3.75 feet. This type of expected fire behavior is likely to exhibit torching (passive crown fire) and less likely to produce lofted embers that start more fires, and these fires generally burn cooler and slower and typically burn in the surface fuels. Fire behavior conditions that would occur under these conditions would range from creeping surface fires with flame lengths less than one foot burning in conifer litter and duff; to active surface fire burning freely in all surface fuels, and

actively torching groups of seedling and sapling sized (1-6 inch DBH) trees. The more active fires may also occasionally torch out individual overstory trees of various sizes as well as small groups of overstory trees with continuous ladder fuels beneath them. These desired forest conditions would provide for diversity within stands without sustaining crown fire. These types of fire are less likely to cause high fire severity effects, less ecosystem damage, and move the forest towards desired conditions. By moving towards these desired conditions for surface and canopy fuels; fire would be allowed to function as a natural disturbance within the ponderosa pine ecosystem without causing loss to ecosystem function or to human safety, lives and values. The desired forest conditions would provide for diversity within stands without sustaining crown fire. These conditions would allow managers to use wildfire and prescribed fire to maintain fuel accumulations within the desirable range, assist in maintaining desirable stand structure, an otherwise perform its role as a natural disturbance factor within the ecosystem. Broadcast and pile burning prescribed fire treatments would occur in this vegetation type under the proposed action.

The pre-treatment fuel model TL8 would move towards a Fuel model TL3; both rates of spread and flame lengths would decrease. Rates of spread for a Fuel Model TL3 would range from 0.5-4 chains per hour (33-264 feet/hour) and flame lengths could range from 6 inches -2 feet. The lower flame lengths indicate that overall fire behavior will primarily exhibit surface spread and the potential for passive and active crown fire events has been reduced significantly.

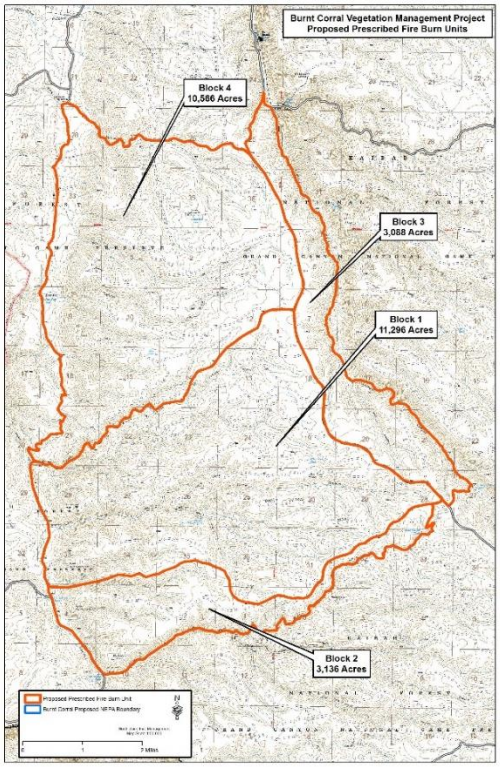
Mixed conifer Vegetation Type

The Proposed Action in the mixed conifer stands improves Canopy Base Height to 4.61 feet, increases the Torching Index to 12.68 mph and lowers Flame Length to 9.93 feet. This type of expected fire behavior is likely to exhibit torching (passive crown fire) and less likely to produce lofted embers that start more fires, and these fires generally burn cooler and slower and typically burn in the surface fuels. Fire behavior conditions that would occur under these conditions would range from creeping surface fires with flame lengths less than one foot burning in conifer litter and duff; to active surface fire burning freely in all surface fuels, and actively torching groups of seedling and sapling sized (1-6 inch DBH) trees. The more active fires may also occasionally torch out individual overstory trees of various sizes as well as small groups of overstory trees with continuous ladder fuels beneath them. These desired forest conditions would provide for diversity within stands without sustaining crown fire. These types of fire are less likely to cause high fire severity effects, less ecosystem damage, and move the forest towards desired conditions. By moving towards these desired conditions for surface and canopy fuels; fire would be allowed to function as a natural disturbance within the ecosystem without causing loss to ecosystem function or to human safety, lives and values. The desired forest conditions would provide for diversity within stands without sustaining crown fire. These conditions would allow managers to use wildfire and prescribed fire to maintain fuel accumulations within the desirable range, assist in maintaining desirable stand structure, an otherwise perform its role as a natural disturbance factor within the ecosystem. Broadcast and pile burning prescribed fire treatments would occur in this vegetation type under the proposed action.

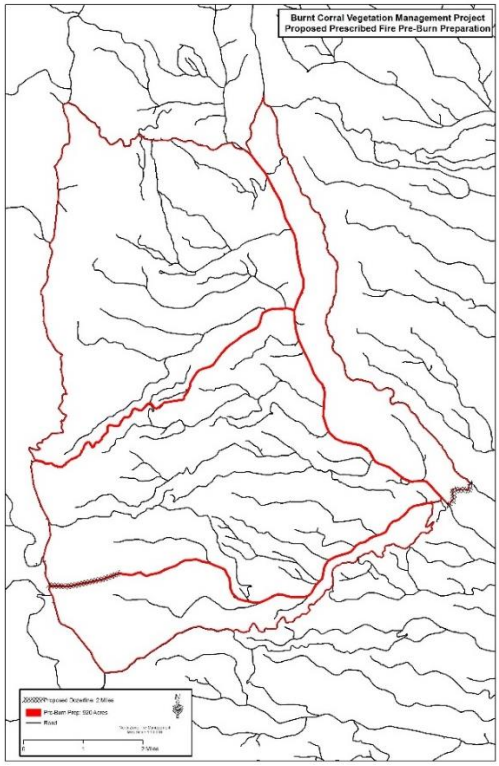
Direct/Indirect Effects common to all Vegetation Types

Wildland fire will be allowed to function as a natural disturbance agent within all three primary vegetation types. For analyses purposes the project area has been divided into 4 potential burn blocks in an effort to display the potential size of future burn blocks and to assess the potential amount of pre-burn preparation activities that may be required. Individual prescribed fire burn plans would be developed for each individual treatment unit. Each prescribed fire burn plan would be developed in coordination with the North Kaibab RD interdisciplinary team. Individual prescribed fire goals, objectives, and treatment prescriptions would be developed for each project. These goals and objectives would be developed to utilize fire as a tool to assist in moving this ecosystem type towards the desired conditions for this vegetation type.

The proposed burn unit boundaries identified on the map below (Map 3) are subject to change as individual burn plans are developed. Based on the DRAFT unit design pre-burn preparation activities (Map 4) along individual burn unit boundaries could involve treating approximately 920 acres. Standard pre-burn prep typically involves reducing dead and down fuel concentrations and reducing understory tree densities within 100 feet of the identified burn unit boundaries. This prep buffer improves firefighter and public safety and reduces the treat of the fire treatment leaving the treatment area. Additionally, fireline may be required to construct or tie in individual burn unit boundaries. The vast majority of burn unit boundaries will involve utilizing the existing roads within the project area. Short sections of fireline may be required and overall fireline that may need to be constructed for this project will be less than 5 cumulative miles. Based on the DRAFT burn unit layout, less than 2 miles of fireline construction is required. All firelines will be rehabbed post treatment.



Map 3: Proposed Burn Units



Map 4: Proposed Pre-Burn Preparation

Pre-Burn Preparation activities could involve utilizing either mechanical (chainsaws) or mechanized [rubber tracked skid-steer with Feconn (Mastication) Head] equipment for fuel reduction activities. Typical pre-burn preparation specifications are listed below:

Example Pre-Burn Prep Specifications:

Thinning Operations:

- Remove 40%-60%trees up to a six inch dbh and above knee height.
- Limb trees up to shoulder height above the ground. Avoid excess scaring of the bole.
- Remove up to 60% of dead-and-down woody debris between 3-12 inches.
- Limb boles greater than 12 inches. DO NOT BUCK INTO INDIVIDUAL ROUNDS to allow for future jackpot burning operations.
- Flush cut all stumps as low to the ground as possible.
- Snags need to be evaluated for worker safety and probability of compromising holding line integrity. Fall if appropriate.
- Scatter slash outside of 100 Foot Prep Buffer and avoid making windrows

Piling Operations:

- All piles shall be constructed of dead and down material. The pile will be triangular in shape. Slash that causes large air spaces in piles shall be cut to eliminate air spaces. Each pile shall include an area of small sized slash (small branches less than ¼ to ½ inch in diameter and/or small branches with needles or leaves attached) to provide "kindling" for prompt ignition and to aid in combustion of larger slash. These fuels shall be placed in the center of the pile.
- Maximum pile size shall be 7 feet in diameter by 7 feet in height, and minimum pile size shall be 5 feet in diameter by 5 feet in height.
- Piles shall not be closer than 10 feet to reserved trees or 25 feet to the treatment unit boundary. Slash shall not be piled or placed on logs, in drainage ditches or roadways.

Cumulative Effects:

Vegetation treatments, past timber sale activity, and large wildfires on the Kaibab Plateau have contributed to the current condition and will contribute to shape the future stand conditions for the area. Over the past 20 years management surrounding the project area has included wildfire suppression, prescribed burning, pile burning, mechanical thinning and various timber harvests as well as grazing and wildlife focused projects. Twenty years will be the temporal boundary considered for this analysis, as it is considered that activities beyond that time period are no longer contributing to effects within the analysis area. There are several projects that are adjacent or are in close proximity to individual treatment area. In 2006, the Warm Wildland Fire Use fire treated approximately **19,000 acres** of vegetation near the Jacob Lake area. The Warm Fire Use reduced fuel loading and has provided an increase in grasses, forbs, and shrubs. During the summer of 2018 the following fires were managed to meet land management objectives, Cat 4,497 acres, Stina 2,606 acres and the Obi 11,656 acres, treating approximately 18,759 acres. During the summer of 2019 the following fires were managed to meet land management objectives Castle 19,368 acres and the Ikes 16,416 acres, treating approximately 35,784 acres. This **19,000 acres** of improved fuel hazard conditions in combination with the 1,734 acres of improved conditions resulting from PFFPP facilities near Jacob lake and the Warm Fire Use area, fires from both 2018 and 2019 managed to meet land management objective 54,543 acres makes a cumulative benefit of 75,277 acres.

The Moquitch CE project is treating approximately **10,000 acres** of forested land south/southwest of the ponderosa pine forest located near Jacob Lake. The Moquitch project is reducing the threat of high intensity wildfires by thinning understory trees, pile burning, and broadcast burning to improve life safety. This project provides cumulatively additive beneficial effects when combined with the proposed action of this project for reduced fuel hazard.

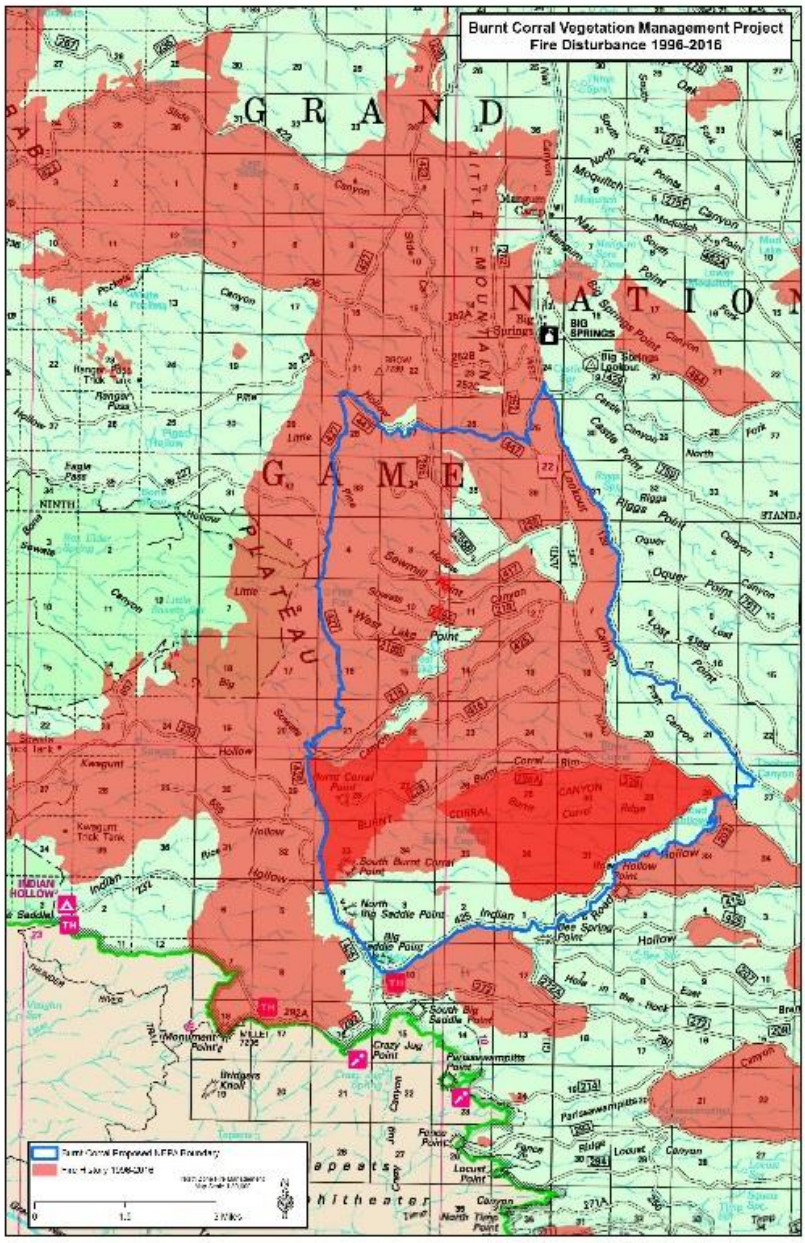
The Jacob Ryan Vegetation Management Environmental Assessment (EA) Project is treating approximately **27,000 acres** to the northeast and southwest of, and surrounding the Jacob Lake Lodge area. This project includes mechanical thinning followed by prescribed burning in phases over several years to increase wildlife habitat, reduce surface fuel conditions, and improve overall forest health. This project is additive to the BCVM project as a beneficial effect for reduced fuel hazard.

The District completed work on the Fracas Wildlife Project project; approximately **3,500 acres**, to the south/southwest of the Jacob Ryan project area. This project included mechanical thinning followed by prescribed burning in phases over several years to increase wildlife habitat, reduce surface fuel conditions, and improve overall forest health. Between 2010-2011, approximately **3,500 acres** were treated with prescribed fire in the Fracas Wildlife project area with success and the area is moving towards a fire adapted uneven-aged stand structure. This project is also additive to PFFPP as a beneficial effect for reduced fuel hazard.

Another foreseeable project would be the Tipover Vegetation project with addition of about **10,000 acres** of underburning to promote fire resistance. This area was harvested with individual selection treatments in the late 1980's and would respond to the treatment with aspen regeneration and fuels reduction.

Another foreseeable project would be the Kaibab Plateau Ecological Restoration Project which is proposing treating approximately **319,000 acres** with prescribed fire. The project encompasses the North Kaibab Ranger District excluding the Burnt Corral Project Area and the two wilderness areas. The project would be carried out over approximately the next 15-20 years. The project is designed to reduce the threat of uncharacteristic high-severity wildfire and restore fire-resilient conditions on the Kaibab Plateau.

The combined effect of these ongoing projects and many foreseeable projects on the Kaibab Plateau will provide for restoration and fuel reduction and will provide for a mosaic of stand conditions, allowing for wildlife habitat and vegetative diversity. This same mosaic would allow for a diversity of fire effects thereby increasing opportunities for the maintenance of forest structure and function using natural and prescribed fire in the long term future. The proposed action alternative would continue to create a mosaic of fuel along the Kaibab Plateau. Under the no action alternative the BCVM project area will continue to be considered a high fire risk area along the Kaibab Plateau with high potential for severe fire effects that impact property, public and firefighter safety. The proposed actions in the BCVM area will provide for fewer negative effects from aggressive fire suppression activities and severe fire behavior.



Map 5: Fire Disturbance Areas 1996-2016

Air Quality:

The Kaibab Plateau area is heavily used as a recreation area for many people. This area represents clear and clean air for many visitors and is important to the continued health of surrounding communities both economically and physically. Smoke, in general is a nuisance and can be adverse to health, but is also part of the natural disturbance associated with these types of ecosystems. Both prescribed and wildfires create smoke, however the amount and timing of these smoke events can be mitigated with prescribed fire. Any prescribed burning will be conducted only with approved site specific burn plans with standard smoke management mitigation and approvals. Burning would be conducted in favorable atmospheric conditions so

as to minimize effects from smoke to nearby communities and recreationist. All burning will be conducted according to Arizona Department of Environmental Quality Regulations. These regulations ensure that effects from all burning within the area are mitigated and that Clean Air Act requirements are met. In general prescribed fires are initiated under conditions that allow managers to control for favorable effects. Prescribed fires will be conducted when conditions are such that overstory tree mortality will be low, which leaves much of the live-tree carbon pool intact. This results in less biomass being combusted than if the area were to burn under higher severity wildfire and therefore less carbon emissions (Wiedinmyer and Hurteau 2010). Smoke impacts from wildfire are less easily mitigated. Wildfires primarily occur during summer months when the project area is most heavily used by recreationist and therefore would most likely have more of an impact on recreation values. The amount of biomass consumed by fire the more smoke that will be produced. When comparing alternatives, the action alternative proposes prescribed burning which will have an impact on surrounding communities and recreationist but in a controllable manner. The outcome of this alternative would also reduce the amount of biomass available to fire during wildfire which would reduce the impact of smoke from such a wildfire. The no action alternative does not propose any prescribed burning; however; it will continue to maintain large amounts of biomass available for consumption in the event of a wildfire, which will have direct and most likely uncontrollable impacts on recreation and surrounding communities.

Discussion and Management Implications:

The proposed action alternative moves the BCVM project area towards desired conditions. The no action alternative maintains and regresses the ecosystem toward more and more unsustainable characteristics. Canopies will continue to close and provide more and more continuous fuel across the landscape. This can be concluded when comparing the existing conditions for CBH, TI, and Flame Length in the FFE and Behave Plus models. These outputs can be directly related to the amount of passive and active crown fire potential. This canopy fuel accumulation has negative effects on understory vegetation and will continue to suppress the production of forbs, grasses, and shrubs. Over time it can be expected that most of the forests will have little to no understory without sunlight penetrating the canopy. The combination of abundant and continuous canopy fuels, the lack of understory vegetation and high fire severity fire potential remains in the project area for the foreseeable future. The proposed action begins to restore the area toward the desired condition.

Literature Cited:

Agee, J. K. 1993. Fire ecology of the Pacific Northwest forests. Washington, D.C.: Island Press. 493p.

Anderson, H.E. 1982. *Aids to Determining Fuel Models for Estimating Fire Behavior*. USDA Intermountain Forest and Range Experiment Station, GTR-INT-122.

Brown, J. K.; E. D. Reinhardt; and K. A. Kramer. 2003. Coarse woody debris: Managing benefits and fire hazard in the recovering forest. USDA Rocky Mountain Research Station RMRS-GTR-105. Available at: http://www.fs.fed.us/rm/publications/online/rmrs_gtr.html

Covington, V. V., and M. M. Moore. 1994. Southwestern ponderosa pine forest structure: changes since Euro-American settlement. Journal of Forestry 92:39-47.

Debano, L.F., D.G. Neary, and P. F. Folliott. 1998. Fire's effects on ecosystems. John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012. p 331

Dixon, G.E. 2002. Essential FVS : A User's guide to the Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Forest Management Service Center. 208p

Domis, Gary. 2015 USDA Forest Service, Kaibab National Forest, North Kaibab Ranger District. *Vegetation Resource Specialist Report for the Burnt Corral Vegetation Management Project.*

Harmon, M.E., Franklin, J.F., Swanson, F.J., et al., Ecology of Coarse Woody Debris in Temperate Ecosystems, Adv. Ecol. Res., 1986, vol. 15, pp. 133–302.

NWCG 1997. *Photo Series for Quantifying Forest Residues in the Southwestern Region*. PMS-822. August 1997.

NWCG 2004 Fireline Handbook. NWCG Handbook 3 PMS410-1 March 2004

Omi, P. N. and E. J Martinson. 2002. Effects of Fuel Treatment on Wildfire Severity, Final Report; Joint Fire Science Program, Western Forest Fire Research Center, Colorado State University, Ft. Collins, CO. http://www.cnr.colostate.edu/frws/research/westfire/finalreports.pdf

Pollet and P. N. Omi 2002. Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. International Journal of Wildland Fire, 2002, 11,1-10

Reinhardt, E. D. and N. L. Crookston, (Technical Editors). 2003. The Fire and Fuels Extension to the Forest Vegetation Simulator. Gen. Tech. Rep. RMRS-GTR-116. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 209 p.

Scott, J.H. and R.E. Burgan, 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO; U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72p.

Scott, J. H. and E. D. Reinhardt, 2001. Assessing crown fire potential by linking models of surface and crown fire behavior. Research Paper RMRS-RP-29. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 59 p.

Strom B. A. and P. Z. Fulé 2007. Pre-wildfire fuel treatements affect long-term ponderosa pine forest dynamics. International Journal of Wildland Fire, 16:128-138.

Swetnam, T. W., C. D. Allen, and J. L. Betancourt. 1999. Applied historical ecology: using the past to manage for the future. Ecological Applications, 9:1253-1265.

Van Wagner 1977. Conditions for the start and spread of crown fire. Can. J. For. Res. 7: 23-34.

Wiedinmyer C. and Hurteau M. D., 2010. Prescribed Fire as a means of reducing forest carbon emissions in the western United States. Environ. Sci. Technol. 2010, 44. 1926-1932.

USDA Forest Service. 2016. *Burnt Corral Vegetation Management Project Rapid Assessment Protocol Plot Monitoring Report*. Kaibab National Forest, Southwestern Region.

USDA Forest Service. 2014. *Kaibab National Forest Land Management Plan*. Kaibab National Forest, Southwestern Region.

USDA Forest Service. 2001. *Review and Update of the 1995 Federal Wildland Fire Management Policy*. January 2001. USDA.

USDA Forest Service. 2009. *Guidance for Implementation of Federal Wildland Fire Management Policy*. February 2009. USDA.

USDA Forest Service. 2011. *Kaibab National Forest Fire Management Plan.* January 2011. Kaibab National Forest, Southwestern Region.

Appendix A
Description of Models used for analysis

Forest Vegetative Simulator/Fire Fuels Extension (FVS/FFE) Model

The Forest Vegetation Simulator (FVS) (Dixon2002) /Fire and Fuels Extension (FFE) (Reinhardt and Crookston 2003) model was used for data analysis. FVS consists of a number of integrated models including those for predicting large-tree height and diameter increment, small-tree height and diameter increment, tree mortality, crown change, tree regeneration establishment, shrub development, shrub and tree vertical canopy distribution, and fire effects. FVS uses stand exam data containing measurements for tree attributes such as diameter-at-breast-height, diameter-at-root-crown, tree height, percent crown, and tree species as well as site attributes to model tree growth and mortality. FVS enables users to model changes to stand attributes such as stocking levels due to management activities such as tree thinning and prescribed fires. Fire effects are modeled in FVS through the Fire and Fuels Extension (FFE) which simulates fuel dynamics and potential fire behavior over time in the context of stand development and management.

Assumptions used:

The Central Rockies Southwestern ponderosa pine variant was used to calculate outputs for FVS and FFE. The potential fire report using default parameters was used to calculate CBH, TI, and Flame Length.

Limitations of the Model:

Live fuels are poorly represented in FVS-FFE

Appendix B
Burning Implementation Strategies

Burn units will be developed utilizing existing roads, trails and natural fire barriers. Some hand or mechanized fire line may be constructed but will be rehabilitated after the full implementation of the prescribed burn. Both fall and spring burning will be allowed and all mitigations (wildlife, soils, silviculture, and visitor use) will be analyzed prior to planning implementation of prescribed burns to identify proper burning prescription parameters. Special consideration will be given to uneven aged stands were intense fire behavior may create a higher mortality to larger size class trees. It is anticipated that there will be some mortality within the vss 5 and 6 size class trees but actions will be taken to reduce that mortality. Reducing mortality in vss 5 and 6 stands together with smoke management techniques will be implemented with the following mitigations:

- Ignite prescribed burns when fuel moistures are high enough to not allow for frequent torching of larger trees.
- Clear dead material away from the base of the trees to prevent torching or root damage.
- Employ ignition techniques that avoid frequent torching of trees.
- Schedule burns to **avoid** meteorological conditions, which would impact smoke sensitive areas.
- Control the ignition and consumption rates (ie. control the emission rate) or schedule for meteorological conditions to permit **dilution** of smoke to tolerable concentrations in designated areas.
- Remove material (fuel) or burn using an efficient firing technique, which minimizes the amount of area and the amount of fuel burning in the smoldering phase (**emission reduction**).

Prescribed burning within this project area will also follow these guidelines:

- A prescribed fire burn plan will be prepared for each unit utilizing the interagency prescribed fire burn plan template. Burn plans will be prepared in accordance with silvicultural and range management prescriptions.
- Adequate rest/rotation will be given to areas that are burned within grazing allotment units. The time frame of 2 years will utilized as a general rule of thumb but will be adjusted based on annual use and monitoring of site production.
- The KNF Forest Plan states as a standard to leave at least 2 snags per acre, 3 downed logs per acre, and 5-7 tons of woody debris per acre, (including the downed logs).
- All prescribed fire activity will be conducted consistent with wildlife time restrictions and mitigations.